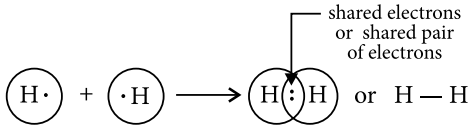
CHAPTER
4

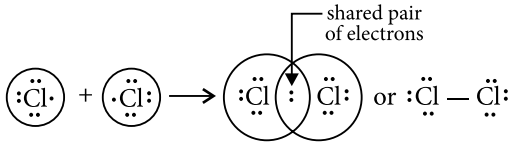
Carbon and its Compounds

Recap Notes

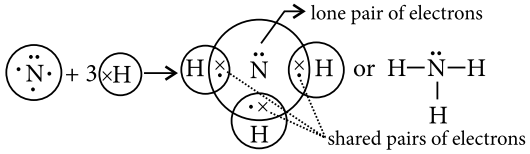
- **Covalent bond :** A chemical bond formed between two atoms by mutual sharing of valence electrons, so that each atom acquires the stable electronic configuration of the nearest noble gas, is known as *covalent bond*.
- **Formation of covalent bonds :**
  - **Formation of hydrogen molecule :**



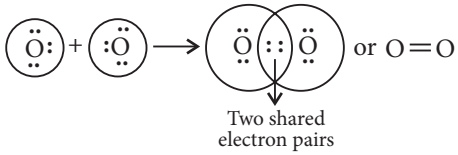
  - **Formation of chlorine molecule :**



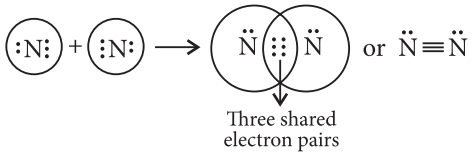
  - **Formation of ammonia molecule :**



  - **Formation of oxygen molecule :**



  - **Formation of nitrogen molecule :**

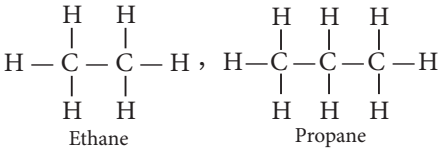


- **Characteristics of covalent compounds:**
  - Covalently bonded molecules have strong bonds within the molecules, but intermolecular forces are small, resulting in low melting and boiling points.
  - Covalent compounds are generally poor conductors of heat and electricity.
- **Covalency :** The number of electrons contributed by each atom for sharing is known as *covalency*.
- **Covalent bonding in carbon :** It is difficult for carbon to lose or gain four electrons because of the following reasons :
  - It cannot gain four electrons to form C^{4-} ion having neon gas (2, 8) configuration because this anion would be highly unstable due to the large amount of energy required to overcome the forces of repulsion between the four electrons being added and the six electrons already present in carbon atom.
  - It cannot lose four electrons to form C^{4+} ion having helium gas (2) configuration because this cation would be highly unstable due to the large amount of energy required to remove four electrons from the carbon atom.
  - Carbon overcomes this problem by sharing its valence electrons with other atoms, *i.e.*, by forming covalent bonds.
- **Allotropes of carbon :** Carbon occurs in different forms in nature :
  - **Diamond :** Each carbon atom is bonded to four other carbon atoms, forming a rigid three-dimensional structure.
  - **Graphite :** In graphite, each carbon atom is bonded to three other carbon atoms in the same plane giving a hexagonal array. These hexagonal arrays are placed in layers one above the other. Graphite is smooth and slippery and very good conductor of electricity.

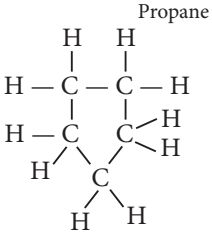
- **Fullerenes :** Fullerenes are another class of carbon allotropes. The first one to be identified was C-60 which has carbon atoms arranged in the shape of a football. Since, this looked like the geodesic dome designed by Buckminster Fuller, the molecule was named fullerene.

- **Versatile nature of carbon :** Carbon is versatile element because it shows following characteristics :
  - **Catenation :** The unique property of self-linking of carbon atoms through covalent bonds to form long straight or branched chains or rings of different sizes is, called *catenation*. Due to this property, carbon forms a large number of organic compounds.
  - **Tetra-covalency of carbon :** Carbon has a covalency of four. It is capable of forming bonds with four other atoms of carbon or atoms of other monovalent elements. Due to small size of carbon, these compounds are exceptionally stable.
  - **Tendency to form multiple bonds :** Due to small size of carbon atom, it can form multiple bonds with carbon, oxygen, sulphur and nitrogen atoms.
  - **Isomerism :** If a molecular formula represents two or more structures having different properties, the phenomenon is called *isomerism*. Isomerism also leads to huge number of carbon compounds.

- **Hydrocarbons :** The compounds which contain only carbon and hydrogen are called hydrocarbons. These are categorised as :
  - **Saturated hydrocarbons :** The compounds in which carbon atoms are linked together with only single covalent bonds, are called *saturated hydrocarbons*.
    Example :

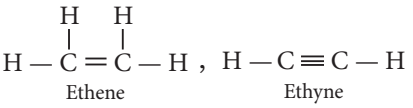

Ethane

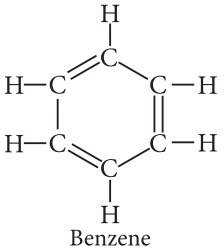
Propane


Cyclopentane

Since carbon – carbon single bonds are very strong therefore, saturated hydrocarbons are usually not very reactive. Also, saturated hydrocarbons contain the maximum number of hydrogen atoms. Saturated hydrocarbons are called alkanes.

  - **Unsaturated hydrocarbons :** The compounds in which one or more (double or triple) bonds are present between carbon atoms are called *unsaturated hydrocarbons*. Unsaturated hydrocarbons with double bonds are called *alkenes* while with triple bonds are called *alkynes*.
    Examples :


Ethene Ethyne


Benzene

Unsaturated hydrocarbons are more reactive than saturated hydrocarbons.

- **Homologous series :** A homologous series is defined as a group of compounds having the same functional group, similar chemical properties in which the successive members differ by a —CH_2 group or 14 mass unit.
  - **Characteristics of homologous series**
    - All compounds in the series can be represented by a general formula, *e.g.*, for alcohol it is $C_nH_{2n+1}OH$, for alkane C_nH_{2n+2}, for alkene C_nH_{2n}, and for alkynes C_nH_{2n-2}, where, n = 1, 2, 3.... .
    - Two successive members of homologous series differ by —CH_2 unit.

n	$C_nH_{2n+1}OH$	
1	CH_3OH	
2	C_2H_5OH	$-CH_2$
3	C_3H_7OH	$-CH_2$
4	C_4H_9OH	$-CH_2$

    - All compounds in the series have similar chemical properties.
    - All members of the series, show a gradual change in their physical properties.
    - Physical properties generally increase as the molecular mass increases.

Practice Time

OBJECTIVE TYPE QUESTIONS

Multiple Choice Questions (MCQs)

1. Which of the following organic compounds does not have the same chemical properties as methanol?

(a) C_2H_6O (b) $C_5H_{10}O$

(c) $C_4H_{10}O$ (d) $C_7H_{16}O$

2. Which of the following is correct about the structure of diamond?

(a) Carbon atoms are held together by single covalent bonds.

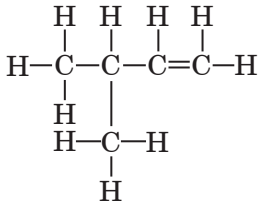
(b) Electrons move freely through the structure.

(c) Layers of atoms slide easily over each other.

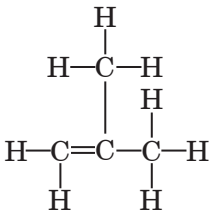
(d) Carbon atoms conduct electricity in the molten state.

3. Which of the following hydrocarbons represents the isomer of butene?

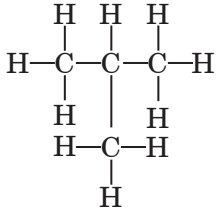
(a)



(b)



(c)



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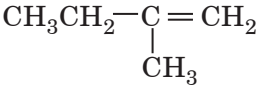
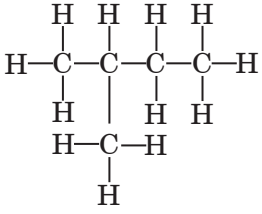
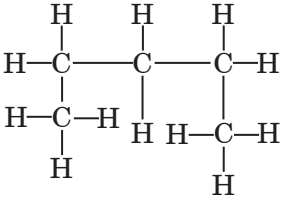


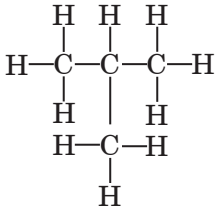
4. The structures of three hydrocarbons, *X*, *Y* and *Z* are shown below:



Hydrocarbon *X*



Hydrocarbon *Y*



Hydrocarbon *Z*

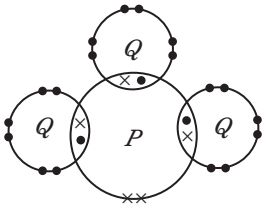
Which of the statements about *X, Y* and *Z* are correct?

1. *X* and *Y* are isomers.
2. *X* and *Y* have the same percentage composition by mass.
3. *Y* is the isomer of alkane having formula, C_5H_{12}.
4. *Z* has the same boiling point as *n*-butane.

(a) 1, 2 and 3 (b) 2 and 4

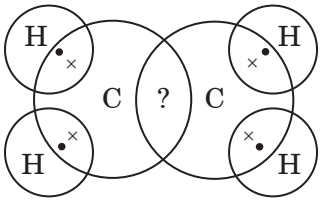
(c) 1 and 4 (d) 1, 3 and 4

5. The diagram given below shows the electron arrangement of the valence electrons in a molecule of compound PQ_3. Which of the following pairs of elements could be *P* and *Q*?



	P	***Q***
(a)	Argon	Neon
(b)	Phosphorus	Hydrogen
(c)	Nitrogen	Chlorine
(d)	Sulphur	Oxygen

6. Number of electrons shared between carbon-carbon atoms in ethene is



(a) 2 (b) 4
(c) 6 (d) 8

7. How many structural isomers are possible for pentane (C_5H_{12})?
(a) 1 (b) 4
(c) 2 (d) 3

8. In C_6H_{14} the number of possible isomers is
(a) 3 (b) 6
(c) 4 (d) 5

9. _____ is widely used as a fuel and is a major component of bio-gas and CNG. It is also one of the simplest compounds formed by carbon.
(a) Ethane (b) Propane
(c) Carbon dioxide (d) Methane

10. Which of the following compounds has a triple bond?
(a) C_2H_4 (b) C_3H_4
(c) C_3H_8 (d) C_4H_{10}

11. Which of the following statements is correct?
(a) Most organic compounds are ionic compounds.
(b) Ethane and ethene belong to the same homologous series.
(c) Propene contains three hydrogen atoms per molecule.
(d) Chloroethane contains two carbon atoms per molecule.

12. All the members of homologous series of alkynes have the general formula
(a) C_nH_{2n} (b) C_nH_{2n+2}
(c) C_nH_{2n-2} (d) C_nH_{2n-4}

13. Three hydrocarbons *X, Y* and *Z* are shown below :

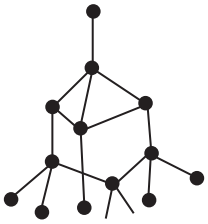
X : $CH_3CH_2CH_2CH_2CH_3$

Y : $CH_3—C \equiv C—CH_2CH_3$

Z : $CH_3CH_2—CH=CH—CH_3$

Identify the incorrect statements about these three hydrocarbons.
I. *X* and *Y* both differ by a $—CH_2$ unit.
II. *X* and *Z* have the same boiling point.
III. All have different general formulae.
IV. *Y* and *Z* have different molecular masses.
(a) I and II
(b) II and III
(c) I and IV
(d) All the statements are incorrect.

14. Graphite is a good conductor of electricity. Diamond is a poor conductor of electricity. Substance *X* is a moderate conductor of electricity. Substance *X* has the structure shown below:



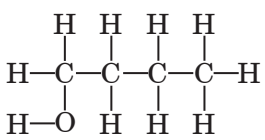
Which statement about substance *X* is correct?
(i) It is a covalent compound.
(ii) It has a giant molecular structure.
(iii) It has the same structure as graphite.
(iv) It has the same structure as diamond.
(a) (i) and (iii) (b) (ii) and (iii)
(c) (ii) and (iv) (d) (i), (ii) and (iv)

15. Which of the following statements is correct about a substance that has a giant covalent structure?
(a) All its ions are arranged in a giant three dimensional lattice.
(b) A large amount of energy is needed to break down the lattice structure.
(c) It conducts electricity in the molten state.
(d) It dissolves in water but is more soluble in organic solvents.

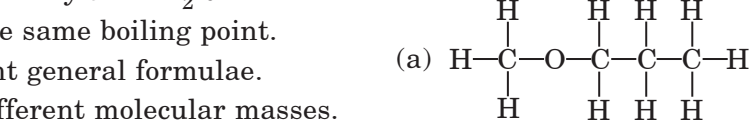
16. The general formula of cycloalkanes is
(a) C_nH_{2n+2} (b) C_nH_{2n-2}
(c) C_nH_{2n-1} (d) C_nH_{2n}

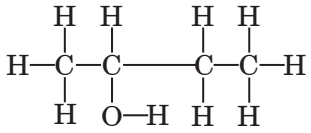
17. Which of the following exists as a simple triatomic molecule?
(a) Argon (b) Fluorine
(c) Nitrogen (d) Ozone

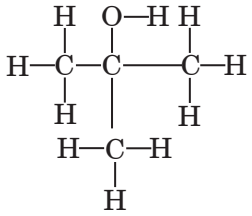
18. The organic compound, *R*, has the structure shown below:

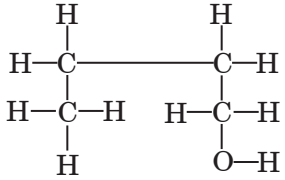


Which structure is not an isomer of *R*?

(a) 

(b) 

(c) 

(d) 

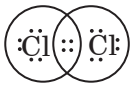
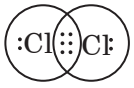
19. Which of the following molecules has all its atoms joined together by double covalent bonds?
(a) Methane (b) Water
(c) Carbon dioxide (d) Nitrogen trichloride

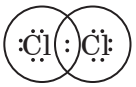
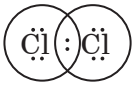
20. Which of the following is not a characteristic of members of a homologous series?
(a) They possess varying chemical properties.
(b) Their physical properties vary in regular and predictable manner.
(c) Their formulae fit the general molecular formula.
(d) Adjacent members differ by one carbon and two hydrogen atoms.

21. Which covalent molecule contains the structure where the central atom is bonded to four other atoms by covalent bonds?
1. Diamond 2. Graphite
3. Methane 4. Silicon dioxide
(a) 1 and 2 (b) 2 and 4
(c) 3 and 4 (d) 1, 3 and 4

22. Which of the following represent saturated hydrocarbons?
1. $CH(CH_3)_3$
2. CH_2CHCH_3
3. $CH_3CH(CH_3)CH_2CH_3$
4. $(CH_3)_2CCHCH_3$
(a) 1 and 3 (b) 2 and 4
(c) 1, 2 and 3 (d) 1, 2, 3 and 4

23. Chlorine forms a diatomic molecule, Cl_2. The electron dot structure for this molecule is

(a)  (b) 

(c)  (d) 

24. Which of the following has shortest carbon-carbon bond length?
(a) C_2H_2 (b) C_2H_4
(c) C_2H_6 (d) C_6H_6

25. Which type of bond is present between carbon-carbon atoms in acetylene?
(a) Single covalent bond
(b) Double covalent bond
(c) Triple covalent bond
(d) Electrovalent bond

26. Number of free electron(s) in each carbon atom in graphite is/are
(a) two (b) four
(c) one (d) three.

27. The table shows the formulae of three organic compounds that belong to the same homologous series.

First member of the homologous series	$CH_3—O—CH_3$
Second member of the homologous series	$CH_3CH_2—O—CH_3$
Third member of the homologous series	$CH_3CH_2CH_2 — OCH_3$

What is the general formula of this series?
(a) $C_nH_{2n}O$ (b) $C_nH_{2n+2}O$
(c) $C_nH_{2n}OH$ (d) $C_nH_{2n+2}OH$

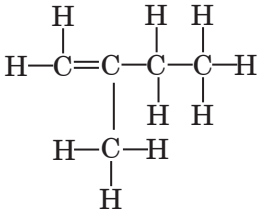
28. Which of the following statements is not correct?
(a) A common functional group is present in different members of a homologous series.
(b) Two consecutive members of a homologous series differ by a $–CH_3$ group.
(c) The members of a homologous series can be represented by one general formula.
(d) Different members of a homologous series have similar chemical properties.

29. Identify the correct statements.
(i) As the molecular mass increases in any homologous series, a gradation in physical properties is seen.
(ii) The melting and boiling points decrease with increasing molecular mass.
(iii) Other physical properties such as solubility in a particular solvent decreases with increasing molecular mass.

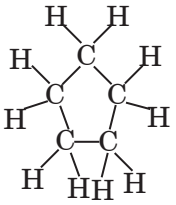
(iv) The chemical properties, which are determined solely by the functional group, remain similar in a homologous series.

(a) (ii) and (iii) (b) (ii) and (iv)
(c) (i), (iii) and (iv) (d) All are correct.

30. The structural formulae of compounds Q and R are shown below :



Compound Q



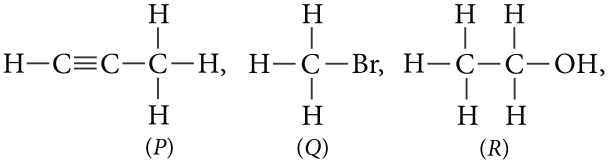
Compound R

Which statement about compounds Q and R is correct?

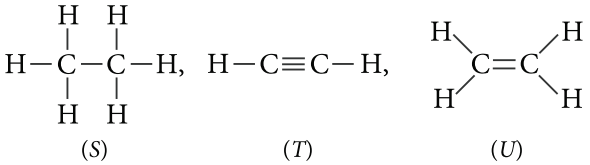
(a) They belong to the same homologous series.
(b) They have the same percentage composition by mass.
(c) They have the same boiling point.
(d) They have different general formulae.

Case Based MCQs

Case I : Read the passage given below and answer the following questions from 31 to 35.



(P) (Q) (R)



(S) (T) (U)

31. Which of the following compounds belong to same homologous series?

(a) S and T (b) T and U
(c) P and U (d) P and T

32. The functional group of compound (R) is

(a) alcohol (b) aldehyde
(c) ketone (d) carboxylic acid.

33. Compound (T) belongs to homologous series of

(a) alkynes (b) alkenes
(c) alkanes (d) none of these.

34. Which of the following compounds is unsaturated hydrocarbon?

(a) S (b) Q
(c) U (d) R

35. Which of the following compounds belongs to alkane series?

(a) P (b) S
(c) T (d) U

Case II : Read the passage given below and answer the following questions from 36 to 40.

Two allotropic forms of carbon which are crystalline in nature, are diamond and graphite. They differ physically but chemically they are similar. Diamond is the hardest crystalline form of carbon. In diamond, each carbon atom is linked to four other carbon atoms by covalent bonds. In graphite, each carbon atom is linked to three other carbon atoms by covalent bond. Graphite is relatively soft and greasy. It is also a good conductor of electricity.

The C — C bond length in graphite is 141.5 pm while in diamond it is 154 pm.

36. Which of the following is a good conductor of heat and electricity?

(a) Coal (b) Diamond
(c) Charcoal (d) Graphite

37. Graphite is a good conductor of electricity because

(a) it has free electrons (b) it has free atoms
(c) it is crystalline (d) it is soft and greasy.

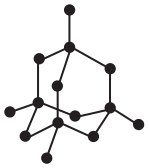
38. Which of the following types of binding forces is present in the structure of diamond?

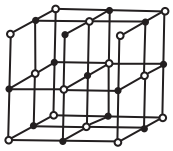
(a) Ionic (b) van der Waals'
(c) Covalent (d) None of these

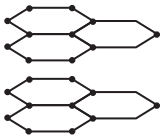
39. Diamond is not a good conductor of electricity because

(a) it is very hard
(b) its structure is very compact
(c) it is not water soluble
(d) it has no free electron.

40. Which of the following is the structure of diamond?

(a) 

(b) 

(c) 

(d) 

Case III : Read the passage given below and answer the following questions from 41 to 45.

The table given below shows six organic compounds *A*, *B*, *C*, *D*, *E* and *F* having different molecular formula :

Organic compound	Molecular formula
A	C_7H_{16}
B	C_8H_{16}
C	C_4H_6
D	C_6H_{10}
E	C_5H_{10}
F	C_9H_{20}

41. Which of the following compounds belong to same homologous series?

(a) *E* and *F* (b) *B* and *C*
(c) *A* and *B* (d) *C* and *D*

42. Which of the following is the member of the same homologous series as *E*?

(a) *D* (b) *A*
(c) *F* (d) *B*

43. Identify the correct statements.

(a) *A* and *F* are saturated hydrocarbons while all others are unsaturated hydrocarbons.
(b) *C* and *D* belong to a homologous series having general formula C_nH_{2n}.
(c) *B* and *E* are alkynes.
(d) All the compounds have same physical and chemical properties.

44. Compound *B* is

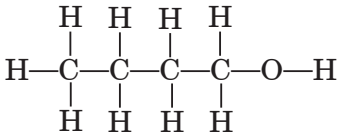
(a) an alkane (b) an alkene
(c) an alkyne (d) none of these.

45. Compound (*F*) has a general formula

(a) C_nH_{2n-2} (b) C_nH_{2n}
(c) C_nH_{2n+4} (d) C_nH_{2n+2}

Case IV : Read the passage given below and answer the following questions from 46 to 50.

An organic molecule has the following structure :



46. To which homologous series does this molecule belong?

(a) Aldehydes (b) Ketones
(c) Alcohols (d) Alkanes

47. What is the general formula of this homologous series?

(a) $C_nH_{2n+1}OH$ (b) C_nH_{2n+2}
(c) $C_nH_{2n}O$ (d) $C_nH_{2n+1}CHO$

48. Which is the next member of this series?

(a) C_4H_9OH (b) C_3H_7OH
(c) $C_5H_{11}OH$ (d) $C_6H_{13}OH$

49. Which is the third member of this series?

(a) C_3H_7OH (b) C_4H_9OH
(c) C_2H_5OH (d) CH_3OH

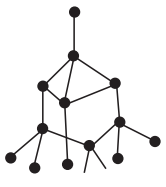
50. Which is the second member of this series?

(a) Ethanol (b) Methanol
(c) Propanol (d) Butanol

Case V : Read the passage given below and answer the following questions from 51 to 55.

When an element exists in two or more different forms in the same physical state, these different forms are called allotropes and the phenomenon is known as allotropy. Allotropes have similar chemical properties but they differ in their physical properties. Carbon exists in crystalline and amorphous forms. In crystalline form, it occurs as diamond, graphite and fullerenes. Diamond is a colourless, transparent substance having extraordinary brilliance. It is the hardest natural substance known. It is used for cutting marble, granite and glass. Graphite is a greyish-black, opaque substance. It is lighter than diamond *i.e.*, it has lower density. It has sheet like structure having hexagonal layers. One layer slides over the other layer which makes it soft to touch. It is the reason that graphite is used as a lubricant.

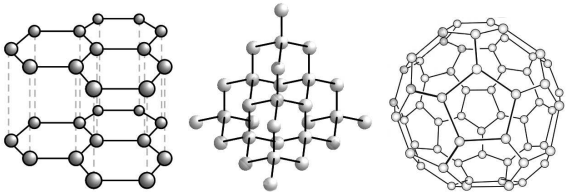
51. Substance *X* is a moderate conductor of electricity. Substance *X* has the structure shown below : Which statements about substance *X* are correct?



(I) It is a covalent compound.
(II) It has a giant molecular structure.
(III) It has the same structure as graphite.
(IV) It has the same structure as diamond.
(a) (I) and (III)
(b) (II) and (III)
(c) (II) and (IV)
(d) (I), (II) and (IV)

52. Which of the following is correct about the structure of diamond?
(a) Carbon atoms are held together by single covalent bonds.
(b) Electrons move freely through the structure.
(c) Layers of atoms slide easily over each other.
(d) Carbon atoms conduct electricity in the molten state.

53. Which three allotropes of carbon, do the given figures represent?

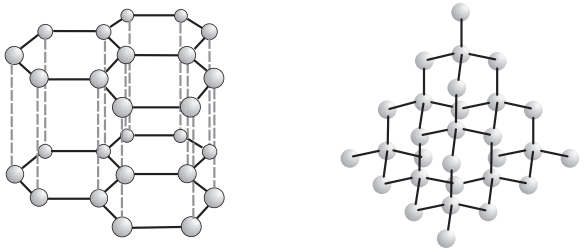


(I) (II) (III)

	(I)	**(II)**	**(III)**
(a)	Diamond	Graphite	Buckminster fullerene
(b)	Graphite	Buckminster fullerene	Diamond
(c)	Diamond	Buckminster fullerene	Graphite
(d)	Graphite	Diamond	Buckminster fullerene

54 Identify the incorrect statement(s).
(I) Diamond is the hardest substance known while graphite is smooth and slippery.
(II) Diamond is made up of billions of carbon atoms. Each carbon atom is bonded to four other carbon atoms in a tetrahedral manner to form a giant lattice. All carbon atoms are bonded by strong covalent bonds.
(III) Graphite is a poor conductor of electricity unlike other non-metals.
(IV) Graphite has a giant covalent structure that is made up of layers of carbon atoms. In each layer, each carbon atom is bonded to three other carbon atoms to form hexagonal rings of carbon atoms.
(a) (I) and (III) (b) Only (III)
(c) (II) and (IV) (d) (I), (II) and (IV)

55. Structures of two different forms of carbon are given below :



I II

Identify the two forms (I and II respectively) and how are they related to each other?
(a) Diamond, Graphite, Isotopes of carbon
(b) Graphite, Diamond, Allotropes of carbon
(c) C^{12}, C^{14}, Allotropes of carbon
(d) C^{14}, C^{12}, Isotopes of carbon

Assertion & Reasoning Based MCQs

For question numbers 56-70, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Both assertion and reason are true, and reason is correct explanation of the assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of the assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

56. Assertion : In alkanes, alkenes and alkynes the valency of carbon is always four.
Reason : All hydrocarbons except alkanes contain double bonds.

57. Assertion : Carbon possesses property of catenation.
Reason : Carbon atoms form double as well as triple bonds during catenation.

58. Assertion : Ethanol is first member of the alcohol homologous series.
Reason : A homologous series can be represented by a general formula.

59. Assertion : Diamond is the hardest natural known substance.

Reason : Diamond is used for cutting marble, granite and glass.

60. Assertion : Diamond is not a good conductor of electricity.

Reason : It has no free electrons.

61. Assertion : Two members of a homologous series have similar chemical properties.

Reason : Propane and butane are members of same homologous series.

62. Assertion : Saturated hydrocarbons are chemically less reactive.

Reason : All the valencies of carbon atom are satisfied by single covalent bonds.

63. Assertion : Covalent compounds are generally poor conductor of electricity.

Reason : They consist of molecules and not ions which can transfer charge.

64. Assertion : Graphite is a good conductor of electricity.

Reason : It has one free valence electron.

65. Assertion : The functional group present in alcohols is –OH.

Reason : It is the same group as present in water, hence water and alcohol have similar properties.

66. Assertion : Diamond and graphite do not have the same crystal structure.

Reason : Diamond is crystalline while graphite is amorphous.

67. Assertion : Carbon and its compounds can be used as fuels.

Reason : They are highly inflammable and have high calorific value.

68. Assertion : Olefins have the general formula C_nH_{2n+1}.

Reason : There is atleast one double bond between two carbon atoms in their molecules.

69. Assertion : Graphite is soft and slippery to touch.

Reason : Graphite has sheet like layered structure.

70. Assertion : Both aldehydes and ketones contain carbonyl group.

Reason : In aldehydes, the functional group is attached to atleast one hydrogen atom.

SUBJECTIVE TYPE QUESTIONS

Very Short Answer Type Questions (VSA)

1. LPG (liquefied petroleum gas) is used as a fuel for cooking in homes. Why is LPG stored as a liquid?

2. Why carbon does not form the ionic compounds?

3. What are covalent compounds?

4. Give different forms in which carbon occurs in nature.

5. Write the molecular formula of first two members of homologous series having functional group —Cl.

6. Write the molecular formula of the 2nd and 3rd member of the homologous series whose first member is methane.

7. Select saturated hydrocarbons from the following :

C_3H_6; C_5H_{10}; C_4H_{10}; C_6H_{14}; C_2H_4

8. Write the name and formula of the 2nd member of homologous series having general formula C_nH_{2n-2}.

9. Give the electron dot structures for (a) CCl_4 and (b) C_2H_2.

10. An organic compound burns with a sooty flame. Is it a saturated or an unsaturated compound?

Short Answer Type Questions (SA-I)

11. The molecular formulae of alkenes *X* and *Y* are C_xH_8 and $C_{10}H_y$ respectively. What are the relative molecular masses of *X* and *Y*?

12. Define isomerism. Write down the structures and names of isomers of butane.

13. What is homologous series of compounds? List any two characteristics of homologous series.

14. A hydrocarbon molecule has 3 carbon atoms. Write down its molecular formula if it is an : (i) alkane (ii) alkene (iii) alkyne.

15. What would be the electron dot structure of carbon dioxide which has the formula CO_2?

16. Explain the nature of the covalent bond using the bond formation in CH_3Cl.

17. What are covalent bonds? Show their formation with the help of electron dot structure of methane. Why are covalent compounds generally poor conductors of electricity?

18. State two properties of carbon which lead to a very large number of carbon compounds.

19. An allotrope of carbon has a molecular mass of 720. Discuss its structure.

20. Two non-metals *A* and *B* combine with each other by sharing of electrons to form compound *C*.
(a) What is the nature of compound *C*?
(b) Will it dissolve in water or organic solvents?
(c) Will it be a good or bad conductor of electricity?
(d) Will it have high or low melting/boiling point ?

Short Answer Type Questions (SA-II)

21. (i) Which allotrope of carbon is used for making cores of lead pencils?
(ii) Which allotrope of carbon is used for making expensive jewellery?
(iii) Name an allotrope of carbon which contains both single and double bonds.

22. What are covalent compounds? Why are they different from ionic compounds? List their three characteristic properties.

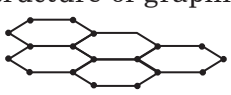
23. Write the molecular formula of the following compounds and draw their electron-dot structures:
(i) Ethane (ii) Ethene (iii) Ethyne

24. Why is homologous series of carbon compounds so called? Write the chemical formula of two consecutive members of any homologous series and state the part of these compounds that determines their (i) physical and (ii) chemical properties.

25. An element *X* has a proton number of 15, while element *Y* has a proton number of 17. Draw a 'dot-and-cross' diagram to show all electrons in a molecule formed from elements *X* and *Y*.

26. (a) What type of bond holds the two chlorine atoms together in a chlorine molecule?
(b) Briefly describe how this bond is formed.
(c) Draw a 'dot-and-cross' diagram to show the bonding in a chlorine molecule.

27. The diagram shows one layer of carbon atoms in the structure of graphite:



(a) Identify the types of bonding in graphite.
(b) Which property of graphite makes it suitable for use as a dry lubricant? Explain your answer.

28. Taking a suitable example show the formation of a molecule bonded by triple covalent bond.

29. What would be the electron dot structure of a molecule of sulphur which is made up of eight atoms of sulphur? (Hint : The eight atoms of sulphur are joined together in the form of a ring).

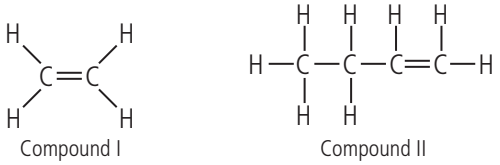
30. What are the two properties of carbon which lead to the huge number of carbon compounds we see around us?

31. What is a homologous series? Explain with an example.

32. (a) Why are most carbon compounds poor conductors of electricity?
(b) Write the name and structure of a saturated compound in which the carbon atoms are arranged in a ring. Give the number of single bonds present in this compound.

33. (a) What is a homologous series of compounds? List any two of its characteristics.
(b) What is the next higher homologue of C_3H_7OH? What is its formula and what is it called?

34. Consider the molecular models of the two organic compounds shown below:



Compound I Compound II

(a) Name the homologous series that compounds I and II belong to and give its general formula.

(b) Write the molecular formulae of next homologue of both compounds I and II.

35. Why are carbon and its compounds used as fuels for most applications?

Long Answer Type Questions (LA)

36. The compounds, methanal, ethanal, propanal and butanal belong to the homologous series, called aldehydes. The table shows some information on these four aldehydes.

Name	Formula	Boiling point/°C	Solubility in water
Methanal	HCHO	–21	Very soluble
Ethanal	CH_3CHO	21	Very soluble
Propanal	CH_3CH_2CHO	49	Soluble
Butanal	$CH_3CH_2CH_2CHO$	76	Slightly soluble

(a) List two characteristics of this homologous series using the information shown in the table.

(b) Compare the molecular formulae of the four aldehydes listed in the table. What conclusion can you make?

(c) Draw the electronic structure of ethanal. You need to show only the outer shell electrons.

37. The table given below shows some information about four organic compounds *P*, *Q*, *R* and *S*.

Organic compound	Molecular formula	Melting point (°C)	Boiling point (°C)
P	C_3H_8	–188	–42
Q	C_4H_{10}	–138	–1
R	C_5H_{12}	–130	36
S	C_6H_{12}	6	80

(a) (i) Which homologous series does C_3H_8 belong to?

(ii) Why are *P*, *Q*, *R* and *S* classified as hydrocarbons?

(b) Which of these organic compounds belong to the alkane series?

(c) Based on the information given above, state one characteristic of the alkane series.

38. (a) State the reason why carbon can neither form C^{4+} cations nor C^{4-} anions, but forms covalent bonds. Also state reasons to explain why covalent compounds

(i) are bad conductors of electricity

(ii) have low melting and boiling points.

(b) Write the structural formula of benzene, C_6H_6.

39. (a) Define the term 'isomers'.

(b) Draw two possible isomers of the compound with molecular formula C_3H_6O and write their names.

(c) Give the electron dot structures of the above two compounds.

40. (a) Why two carbon atoms cannot be linked by more than three covalent bonds.

(b) Explain the following :

(i) Diamond is a covalent solid, yet has high melting point.

(ii) Graphite is a good conductor of electricity but diamond is not.

(iii) Diamond is used for making tools for cutting and drilling.

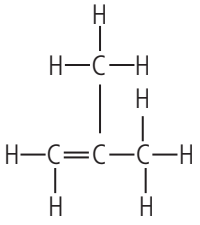
ANSWERS

OBJECTIVE TYPE QUESTIONS

1. (b) : Methanol is an alcohol having general formula $C_nH_{2n+1}OH$ or $C_nH_{2n+2}O$. C_2H_6O, $C_4H_{10}O$ and $C_7H_{16}O$ belong to same series except $C_5H_{10}O$. Thus, $C_5H_{10}O$ does not have same chemical properties as methanol.

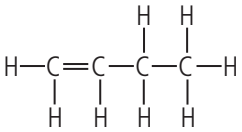
2. (a)

3. (b) :



2-Methylpropene (molecular formula: C_4H_8)

The molecular formula of butene is C_4H_8. The structural formula of butene is:



Thus, 2-methylpropene and butene are isomers, because they have the same molecular formula but different structural formulae.

4. (a) : Statement 1 : *X* and *Y* have the same molecular formula, C_5H_{12} but different structural formulae. *X* is a branched chain alkane $CH_3CHCH_2CH_3$ and *Y* is the straight

chain alkane $CH_3CH_2CH_2CH_2CH_3$.

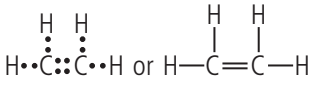
Statement 2 : Since *X* and *Y* have the same molecular formula, they must have the same percentage composition by mass.

Statement 3 : *Y* is *n*-pentane. It is a structural isomer of pentane having formula C_5H_{12}.

Statement 4 : *Z* is 2-methylpropane. It is the isomer of butane. Isomers have different boiling points.

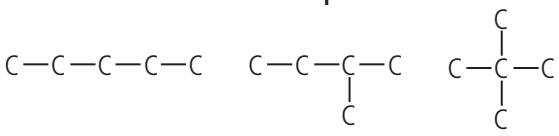
5. (c) : As *P* contains five valence electrons so it could be nitrogen or phosphorus and as *Q* contains seven valence electrons so it should be chlorine. So the correct answer is (c).

6. (b) : Ethene contains a double covalent bond formed by sharing two pairs of electrons.

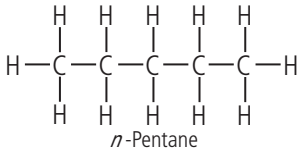


7. (d) : The hydrocarbon pentane of molecular formula C_5H_{12} can have three kinds of carbon atoms skeleton, and hence, will have three isomers.

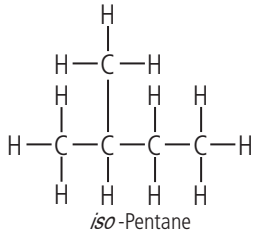
Skeleton of carbon atoms in pentane:



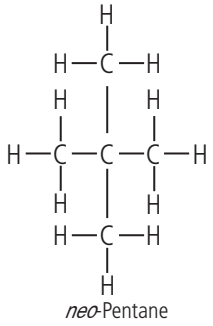
Structural formula of pentane:



n-Pentane



iso-Pentane

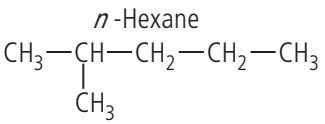


neo-Pentane

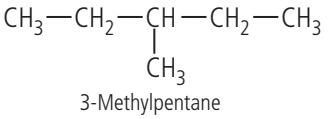
8. (d) : C_6H_{14}

(i) $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$

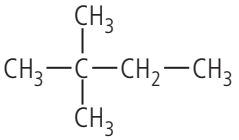
n-Hexane

(ii) 

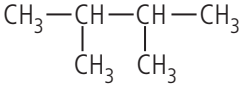
2-Methylpentane

(iii) 

3-Methylpentane

(iv) 

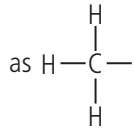
2, 2-Dimethylbutane

(v) 

2, 3-Dimethylbutane

9. (d)

10. (b) : C_3H_4 or propyne has a triple bond. It belongs to the homologous series of alkynes with general formula C_nH_{2n-2}.

Its structure can be shown as  .

11. (d) : The term 'eth' in ethane means that the organic compound contains two carbon atoms per molecule.

The formula of chloroethane is CH_3CH_2Cl. The term 'chloro' refers to the chlorine atom in the organic molecule.

Organic compounds are simple, covalent molecules.

The term 'ane' refers to the alkane series, and 'ene' refers to the alkene series.

The prefix (first part of the name) refers to the number of carbon atoms in each organic molecule. 'Prop' indicates three carbon atoms per molecule. Each propene molecule has six hydrogen atoms.

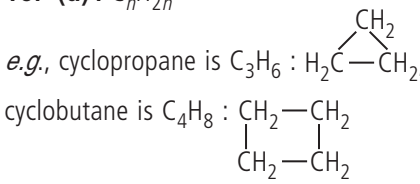
12. (c) : Alkynes have the general formula C_nH_{2n-2}. *e.g.,* Ethyne (C_2H_2), Propyne (C_3H_4), Butyne (C_4H_6).

13. (a) : I. *Y* is an unsaturated carbon compound containing lesser number of hydrogen atoms as compared to *X*.
II. *X* (alkane) and *Z* (alkene) have different boiling points.
III. *X* is an alkane with general formula C_nH_{2n+2}, *Y* is an alkyne with general formula C_nH_{2n-2} and *Z* is an alkene with general formula C_nH_{2n}.
IV. Molecular mass of *Y* (C_5H_8) = 5 × 12 + 8 × 1 = 68
Molecular mass of *Z* (C_5H_{10}) = 5 × 12 + 10 × 1 = 70
∴ *Y* and *Z* have different molecular masses.

14. (c) : Each atom is covalently bonded to four other atoms, which in turn, are bonded to four more atoms. Thus, *X* is a giant molecule and has a structure similar to that of diamond. Substance *X* is not a compound as it consists of only one type of atoms. Thus, *X* is an element. Graphite has layers of carbon atoms.

15. (b)

16. (d) : C_nH_{2n}



e.g., cyclopropane is C_3H_6 : $H_2C(CH_2)CH_2$,
cyclobutane is C_4H_8 : $CH_2(CH_2)CH_2$ / $CH_2(CH_2)CH_2$

17. (d) : Ozone exists as a simple triatomic molecule, O_3.

18. (d) : Structural formula of *R* and alcohol given in option (d) is same. Hence they represent same alcohol.
The molecular formula of *R* is $C_4H_{10}O$.
The compounds given in options (a), (b) and (c) have the same molecular formula as *R* : $C_4H_{10}O$. But they have different structural formulae from that of *R*. Hence, they are isomers of *R*.

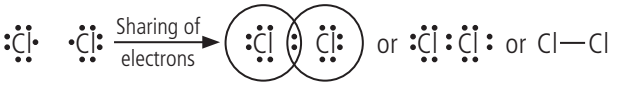
19. (c) : O = C = O

20. (a) : All the members of homologous series show similar chemical properties.

21. (d) : In graphite, each carbon atom is covalently bonded to three other carbon atoms.

22. (a) : $CH_3-CH(CH_3)-CH_3$ (1) $CH_2=CH-CH_3$ (2)
$CH_3-CH(CH_3)-CH_2-CH_3$ (3) $CH_3-C(CH_3)=CH-CH_3$ (4)

23. (c) : In chlorine molecule, both chlorine atoms contribute one electron and thus share single electron pair to form single covalent bond. As shared pair is shared by both atoms, they acquire inert gas configuration of argon atom in valence shell.



One shared electron pair

24. (a) : HC ≡ CH has shortest bond length as triple bond is shorter than double bond which is further shorter than single bond.

25. (c) : H — C ≡ C — H
Acetylene

26. (c) : In graphite, one carbon atom is attached to three other carbon atoms leaving one electron free.

27. (b) : Molecular formula of first member : C_2H_6O
Molecular formula of second member : C_3H_8O
Molecular formula of third member : $C_4H_{10}O$
Thus, the general formula of the homologous series is $C_nH_{2n+2}O$.

28. (b) : Two consecutive members of a homologous series differ by a $—CH_2$ group.

29. (c) : The melting and boiling points increase with increasing molecular mass.

30. (b) : Compounds *Q* and *R* have the same molecular formula, C_5H_{10}. Hence they have the same percentage composition by mass.
Compound *Q* is an unsaturated hydrocarbon and compound *R* is a saturated hydrocarbon. They do not belong to the same homologous series.
Compounds *Q* and *R* are different compounds. Hence, they have different boiling points.
Compounds *Q* and *R* have the same general formula, C_nH_{2n}.

31. (d) : (*P*) and (*T*) are alkynes.

32. (a) : Alcohol (–OH).

33. (a) : (*T*) is an alkyne having general formula of C_nH_{2n-2}.

34. (c) : (*U*) is an alkene.

35. (b)

36. (d)

37. (a)

38. (c)

39. (d) : In diamond, one carbon is attached to four other carbon atoms hence it has no free electron.

40. (a)

41. (d) : *A* and *F* are alkanes ; *B* and *E* are alkenes ; *C* and *D* are alkynes.

42. (d) : *B* is an alkene having general formula C_nH_{2n}, the homologous series to which *E* belongs.

43. (a) : *C* and *D* belong to a homologous series having general formula C_nH_{2n-2}. *B* and *E* are alkenes. All the compounds have different physical and chemical properties.

44. (b) : (*B*) is alkene.

45. (d) : (*F*) is an alkane.

46. (c) : Alcohol (—OH).

47. (a) : $C_nH_{2n+1}OH$ is the general formula of the homologous series of alcohol.

48. (c)

49. (a)

50. (a) : Ethanol; C_2H_5OH is the second member of this series.

51. (c) : Each atom is covalently bonded to four other atoms, which in turn, are bonded to four more atoms. Thus, *X* is a giant molecule and has a structure similar to that of diamond. Substance *X* is not a compound as it consists of only one type of atoms. Thus, *X* is an element. Graphite has layers of carbon atoms.

52. (a)

53. (d)

54. (b) : In graphite only three valence electrons are used for bond formation and hence fourth electron is free to move which makes it a good conductor of electricity.

55. (b) : Given structures are of graphite and diamond and these are allotropes of carbon.

56. (c) : Only alkenes contain double bond, alkynes contain triple bond, but in all hydrocarbons carbon remains tetravalent.

57. (b) : Catenation property of carbon is primarily due to its small size, electronic configuration and unique strength of carbon-carbon bonds.

58. (d) : Methanol is first member of the alcohol homologous series.

59. (b)

60. (a) : In diamond, one carbon atom is attached to four other carbon atoms, hence it has no free electron.

61. (b) : All the members of homologous series contain the same functional group, show gradation in physical properties and similarity in chemical properties.

62. (a)

63. (a)

64. (a)

65. (c) : In alcohols –OH group is attached to an alkyl group hence water and alcohol have different properties.

66. (c) : In diamond, C-atoms are sp^3 hybridized while in graphite, they are sp^2 hybridized. Diamond and graphite both are crystalline forms of carbon.

67. (a)

68. (d) : Olefins are unsaturated hydrocarbons. There is at least one double bond between two carbon atoms in their molecules and they have the general formula C_nH_{2n}.

69. (a)

70. (b)

SUBJECTIVE TYPE QUESTIONS

1. LPG is stored as a liquid so that more fuel can be kept in a container. Liquids contain more particles per unit volume than gases. It is also easier to transport liquids than gases.

2. For formation of ionic compounds, carbon should either gain four electrons to form C^{4-} ions or should lose four electrons to form C^{4+} ions but formation of both these ions is not possible due to high energy considerations.

3. A covalent compound is a molecule formed by covalent bonds, in which the atoms share one or more pairs of valence electrons.

4. Carbon occurs in free form *e.g.*, graphite and diamond, in combined form like carbon dioxide, carbonates, etc.
In earth's crust – 0.02% and in atmosphere – 0.03%.

5. The molecular formula of first two members of homologous series having –Cl functional group are CH_3Cl and CH_3CH_2Cl.

6. Methane, CH_4 is an alkane. Alkanes have general formula, C_nH_{2n+2}.

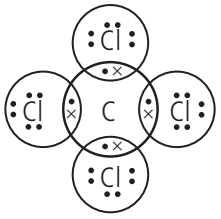
2nd member of homologous series of alkanes is C_2H_6 *i.e.*, ethane.

3rd member of homologous series of alkanes is C_3H_8 *i.e.,* propane.

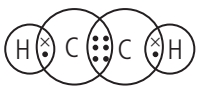
7. Saturated hydrocarbons have general formula, CnH_{2n+2}. Among the given compounds only C_4H_{10} and C_6H_{14} satisfy the above formula. Thus, these are saturated hydrocarbons.

8. General formula, C_nH_{2n+2} belongs to alkyne series. The second member of this series is propyne *i.e.*, (C_3H_4) or $CH_3 — C \equiv CH$.

9. (a) : Carbon has 4 valence electrons and chlorine has 7 valence electrons.



(b)



10. It is an unsaturated compound. Unsaturated compounds have more percentage of carbon as compared to saturated compounds. Thus, unsaturated compounds undergo incomplete combustion in the presence of air producing a yellow flame with lots of black smoke.

11. The general formula of an alkene is C_nH_{2n}.
Thus, the molecular formula of *X* is C_4H_8, and the molecular formula of *Y* is $C_{10}H_{20}$.

Molecular mass of $X = (4 \times 12) + (8 \times 1) = 56$
Molecular mass of $Y = (10 \times 12) + (20 \times 1) = 140$

12. Two or more compounds having same molecular formula but different structural arrangements of atoms in their molecules are called isomers. This phenomenon is called isomerism.

$$CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$$

iso -Butane
(IUPAC name : 2-Methylpropane)

$$CH_3 - CH_2 - CH_2 - CH_3$$

n-Butane
(IUPAC name : Butane)

13. A series of compounds having similar structures and similar chemical properties in which the successive member differs in their molecular formula by $-CH_2$ group is called homologous series.

Characteristics :

(a) All the members of homologous series have similar chemical properties.

(b) Any two consecutive members differ in their molecular formula by a $-CH_2$ group.

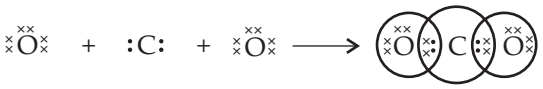
14. The number of carbon atoms in the molecule of this hydrocarbon is 3, that is, $n = 3$.

(i) The general formula of an alkane is C_nH_{2n+2}. On putting $n = 3$, we get $C_3H_{2\times3+2}$ or C_3H_8 (propane).

(ii) For alkene having general formula C_nH_{2n}, we get, $C_3H_{2\times3}$ or C_3H_6 (propene).

(iii) For alkyne having general formula C_nH_{2n-2} we get $C_3H_{2\times3-2}$ or C_3H_4 (propyne).

15. The atomic number (Z) for carbon is six and its electronic configuration is 2, 4. Carbon has four valence electrons. Each oxygen atom ($Z = 8$) has six valence electrons (2, 6). In order to complete its octet, the carbon atom shares its four valence electrons with the four electrons of the two oxygen atoms as follows :

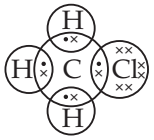


Carbon dioxide

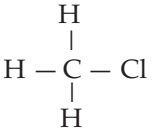
or $O = C = O$

Thus, in carbon dioxide molecule, the carbon atom is linked to two oxygen atoms by two shared pairs of electrons resulting in double bonds on either sides. Both carbon and oxygen atoms complete their octet as a result of electron sharing.

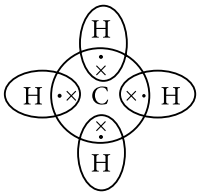
16. The molecule of chloromethane (CH_3Cl) consists of three elements *i.e.*, carbon ($Z = 6$), hydrogen ($Z = 1$) and chlorine ($Z = 17$). Carbon atom has four valence electrons (2, 4) ; hydrogen has one (1) while chlorine has seven electrons in the valence shell (2, 8, 7). In order to complete its octet, carbon shares three valence electrons with three hydrogen atoms while one is shared with the electron of chlorine atom. The structure of covalent molecule may be written as follows :



or



17. Covalent bonds are those bonds which are formed by sharing the valence electrons between two atoms. Electron dot structure of methane is shown in the figure. Covalent compounds are generally poor conductors of electricity because they do not have free electrons or ions.

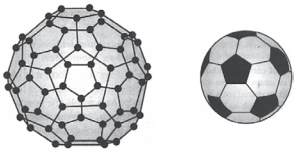


18. Carbon forms a large number of carbon compounds like long chains which may be straight or branched chains or ring of different sizes due to its tetravalency and unique property of catenation. Carbon due to its small size forms exceptionally stable compounds by forming strong bonds.

19. Atomic mass of C = 12 and molecular mass of an allotrope of carbon 720.

$\therefore$ No. of C atoms = 720/12 = 60.

Thus, the allotrope of carbon is C_{60}, *i.e.*, Buckminster fullerene and its structure is similar to a soccer ball.



20. (a) Covalent

(b) Usually soluble in organic solvents

(c) Bad conductor

(d) Usually low melting / boiling point.

21. (i) Graphite (ii) Diamond (iii) Graphite

22. Covalent compounds are those compounds which are formed by sharing of valence electrons between the atoms *e.g.*, Hydrogen molecule is formed by mutual sharing of electrons between two hydrogen atoms.

They are different from ionic compounds as ionic compounds are formed by the complete transfer of electrons from one atom to another *e.g.*, NaCl is formed when one valence electron of sodium gets completely transferred to outer shell of chlorine atom.

The characteristic properties of covalent compounds are :

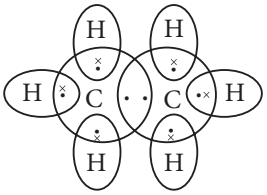
(i) They are generally insoluble or less soluble in water but soluble in organic solvents.

(ii) They have low melting and boiling points.

(iii) They do not conduct electricity as they do not contain ions.

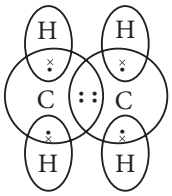
23. (i) Molecular formula of ethane is C_2H_6.

Its electron dot structure is :



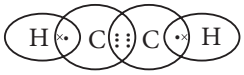
(ii) Molecular formula of ethene is C_2H_4.

Its electron dot structure is :



(iii) Molecular formula of ethyne is C_2H_2.

Its electron dot structure is :



24. A homologous series is the family of organic compounds having the same functional group, similar chemical properties but the successive (adjacent) members of the series are differ by a CH_2 unit or 14 mass units.

Consecutive members of the homologous series of alcohols are :

$$\left.\begin{matrix} CH_3OH \\ C_2H_5OH \end{matrix}\right] \text{They differ by } -CH_2 \text{ unit.}$$

The physical properties are determined by alkyl group/ hydrocarbon part/part other than the functional group.

The chemical properties are determined by functional group such as —OH group.

25. Electronic configuration of *X* : 2, 8, 5

Atom *X* contributes three electrons for sharing.

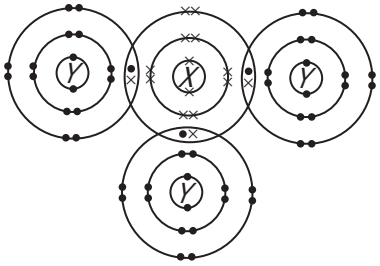
Electronic configuration of *Y* : 2, 8, 7

Each atom of *Y* contributes one electron for sharing.

Therefore, three atoms of *Y* contribute three electrons for sharing.

One atom of *X* will share three pairs of electrons with three atoms of *Y* to achieve the noble gas configuration.

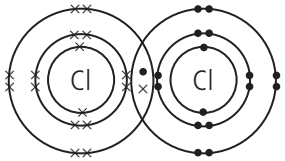
Both atoms *X* and *Y* achieve the electronic configuration of argon (2, 8, 8).



26. (a) Covalent bond

(b) The two chlorine atoms share one pair of electrons, so that both atoms achieve a noble gas configuration.

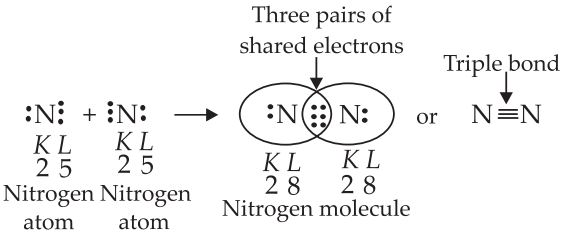
(c)



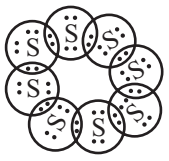
27. (a) Covalent bonds between carbon atoms in each layer and van der Waals' forces between the layers of carbon atoms.

(b) Graphite is soft. The layers of carbon atoms can slide and glide over each other because the weak van der Waals' forces between the layers are easy to overcome.

28. Nitrogen (atomic number 7) atom has an electronic configuration of $\underset{2\ 5}{K\ L}$ indicating the presence of 5 electrons in the outermost *L*-shell. Thus, each nitrogen atom needs three electrons to attain the nearest stable noble gas electronic configuration of neon gas. So, two nitrogen atoms combine together by sharing 3 electrons each to form a molecule of nitrogen.



29. The atomic number (*Z*) of sulphur is sixteen and its electronic configuration is 2, 8, 6. The sulphur atom has six valence electrons. The chemical formula of sulphur molecule is S_8. Each sulphur atom is linked to similar atoms on either sides by single covalent bonds and thus, completes its octet. The molecule is in the form of a ring also represented by crown shape.



Ring structure of S_8 molecule

30. (i) Catenation : Carbon has the unique property of self linking which is known as catenation. In fact, any number of carbon atoms can be linked to one another by covalent bonds. This is on account of the stability of C — C bonds since the size of the carbon atom is quite small.

(ii) Linking of carbon with other atoms : Carbon is tetravalent in nature and can readily unite with atoms like hydrogen, oxygen, nitrogen, sulphur, etc. by electron sharing.

31. A homologous series can be defined as a family of organic compounds having the same functional group, similar

chemical properties and the successive members of which differ by a – CH_2 group or 14 mass units. For example, CH_3OH (methanol), CH_3CH_2OH (ethanol), $CH_3CH_2CH_2OH$ (propanol), $CH_3CH_2CH_2CH_2OH$ (butanol), etc. constitute a homologous series of alcohols. They have the same functional group, *i.e.*, —OH (hydroxyl). Since they have the same functional group, they show similar chemical properties. The difference between any two successive members is a —CH_2 group and 14 mass units. Their physical properties such as melting point and boiling point increase as the molecular mass increases. Their solubility in water, however, decreases with increase in molecular mass.

32. (a) Due to catenation, carbon forms covalent bonds with the constituent elements in the carbon compounds, hence it does not have mobile electrons and carbon compounds do not dissociate themselves into ions and hence, they are poor conductor of electricity.

(b) Structure : 

Name : Cyclopentane

Number of single bonds : 15

33. (a) A homologous series is the family of organic compounds having the same functional group, similar chemical properties but the successive (adjacent) members of the series are differ by a CH_2 unit or 14 mass units.

Two characteristics of homologous series are :

(i) The successive compounds of the homologous series differ by —CH_2 unit *i.e.* 14 mass units.

(ii) Each homologous series belongs to similar class of compounds which shows the same properties.

(b) Next higher homologue of C_3H_7OH is C_4H_9OH *i.e.*, butanol.

34. (a) Alkenes with general formula C_nH_{2n}.

(b) Next homologue of compound (I) is C_3H_6 *i.e.*, propene and next homologue of compound (II) is C_5H_{10} *i.e.*, pentene.

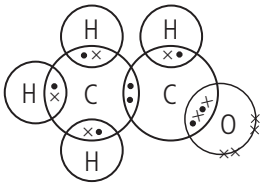
35. Carbon burns in oxygen or air to form carbon dioxide gas. The reaction is highly exothermic. That is why different forms of coal are used as fuels. The most important compounds of carbon are hydrocarbons. Just like carbon, hydrogen also readily burns in oxygen or air to form water producing heat. The hydrocarbon methane (CH_4) is a constituent of natural gas. Propane (C_3H_8) and butane (C_4H_{10}) are present in liquid petroleum gas (L.P.G.). Petrol and kerosene also contain different hydrocarbons. Therefore, these are used as fuels.

36. (a) They have the same functional group, — CHO group. There is a gradual change in their physical properties. Boiling points of aldehydes increase and their solubility in water decreases as their molecular sizes increase.

(b) Comparing the molecular formulae:

Aldehydes	**Molecular formula**
Methanal	CH_2O
	$\downarrow +CH_2$
Ethanal	C_2H_4O
	$\downarrow +CH_2$
Propanal	C_3H_6O
	$\downarrow +CH_2$
Butanal	C_4H_8O

Conclusion : Each member of the series differs from the next by a —CH_2 unit.

(c) 

37. (a) (i) As C_3H_8 has general formula C_nH_{2n+2} thus it belongs to alkane.

(ii) *P*, *Q*, *R* and *S* are classified as hydrocarbons because these compounds are made up of carbon and hydrogen only.

(b) C_3H_8, C_4H_{10} and C_5H_{12} all have general formula C_nH_{2n+2} thus, all of these belong to alkanes.

(c) They have general formula C_nH_{2n+2} and their melting points and boiling points increase with increase in molecular mass.

38. (a) Ionic compounds are formed either by gaining or losing electrons from the outermost shells, but carbon which has four electrons in its outermost shell cannot form ionic bonds because

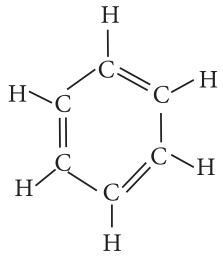
– If carbon forms ionic bonds by gaining four electrons to attain a noble gas configuration then it would be difficult for six protons in the nucleus to hold ten electrons.
– If carbon forms ionic bonds by loss of four electrons then it would require a lot of energy to remove these electrons from outermost shell.

Due to these reasons carbon forms covalent bonds by sharing the valence electrons.

(i) Covalent compounds are generally poor conductors of electricity because they do not have free electrons or ions.

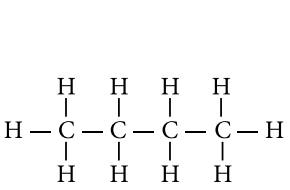
(ii) Covalent compounds have low melting and boiling points because the forces of attraction between molecules of covalent compounds are very weak. On applying a small amount of heat these molecular forces break.

(b)

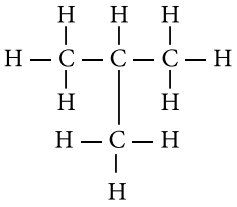


39. (a) Isomers are those molecules which have the same molecular formula but different structural formula *i.e.*, show different properties.

The structures of possible isomers of butane (C_4H_{10}) are :



n-Butane
(I)



2-Methylpropane
(II)

The first three members of alkane series are :

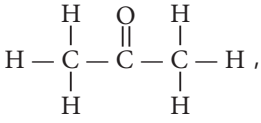
(i) CH_4 (methane)

(ii) C_2H_6 (ethane)

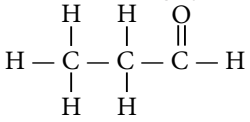
(iii) C_3H_8 (propane)

In the above members of alkane series, it is not possible to have different arrangements of carbon atoms. Thus, we cannot have isomers of first three members of alkane series.

(b) Two possible isomers of the compound, C_3H_6O are :

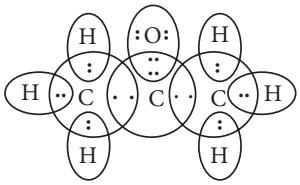


Propanone

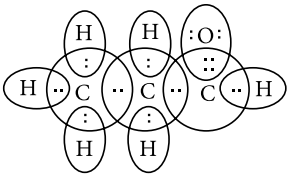


Propanal

(c) The electron dot structures of propanone and propanal are :



Propanone



Propanal

40. (a) Since the maximum angle strain is obtained when the two carbon atoms are linked by three covalent bonds, therefore, two carbon atoms cannot be linked to each other by more than three covalent bonds.

(b) (i) It is a giant molecule containing a large number of carbon-carbon single covalent bonds. To break these covalent bonds, a large amount of energy is needed and hence diamond has a high melting point.

(ii) Graphite has two-dimensional layered structure containing fused hexagonal rings of carbon atoms. Only three valence electrons are used for bond formation while the fourth electron is free to move.

Due to ability of this free electron to move, graphite is a good conductor of heat and electricity. Since in diamond, all the four electrons are involved in bond formation, therefore, diamond is a bad conductor of electricity.

(iii) Diamond is a good conductor of heat and is used for making cutting and drilling tools because the heat generated during cutting and drilling is easily absorbed by the network structure without overheating the diamond tool.

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